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16. ABSTRACT

Audit materials containing Principal Organic Hazardous Constituents (POHCs) have been developed by AREAL for use by federal, state, and local agencies or their contractors to assess the accuracy of measurement methods during RCRA trial burn tests. Audit materials are currently available for 27 gaseous organics in 5, 6, 7, and 9 component mixtures at parts-per-billion levels (7 to 10,000 ppb) in compressed gas cylinders in a balance gas of nitrogen. The criteria used for the selection of the gaseous organic compounds is described.

Stability studies indicate that all of the organics tested (with the exception of ethylene oxide and propylene oxide below 10 ppb levels) are stable enough to be used as reliable audit materials.

Subsequent to completion of the stability studies, 202 performance audits have been initiated with the audit materials to assess the accuracy of the Volatile Organic Sampling Train (VOST) and bag measurement methods during or prior to RCRA trial burn tests. Results of those audits and a summary table of the audits conducted for each POHC and the measurement system audited is described in this report. Audit results obtained with the audit bases during or prior to RCRA trial burn tests are generally within ± 50% of the audit concentrations.

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FOREWORD

Source measurement and monitoring efforts are designed to anticipate potential environmental problems, to support regulatory actions by developing data bases needed in developing regulations and to provide means of monitoring compliance with regulations. The Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, North Carolina, has the responsibility for implementation of agency-wide Quality Assurance programs for air pollution measurement systems; and supplying technical support to other groups in the Agency including the Office of Solid Waste, the Office of Air and Radiation, the Office of Toxic Substances, and the Office of Enforcement.

The need for reliable standards for auditing and documenting the accuracy of source emission measurement of organic hazardous pollutants is well established. The Quality Assurance Division of EPA's Atmospheric Research and Exposure Assessment Laboratory has responded to this need through the development of compressed gas cylinders containing gaseous organic compounds in parts-per-billion (ppb) levels. The primary objectives of this on-going project are (1) to evaluate the quality of measurements made by federal, state/local agencies, or their contractors, by using ppb gas cylinders for performance audits during hazardous waste trial burn tests; (2) to verify the manufacturer's certified analysis of the multicomponent gas mixtures, (3) to determine the stability of the gas mixtures with time, and (4) to develop new audit materials as requested by EPA. This report describes the current status of this project. Included in the report are (1) a description of the criteria used for the selection of organic compounds; (2) a description of the audit procedure, and (3) currently available audit results for RCRA trial burn tests and an example of stability data.

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NOTICE

The information in this document has been funded wholly or in part by the United States Environmental Protection Agency under Contract No. 68-02-4550 to Research Triangle Institute. It has been subjected to the Agency's peer and administrative review, and it has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

Audit materials containing Principal Organic Hazardous Constituents (POHCs) have been developed by EPA for use by federal, state, and local agencies or their contractors to assess the accuracy of measurement methods during RCRA trial burn tests. Audit materials are currently available for 27 gaseous organics in five, six, seven and nine component mixtures at parts-per-billion levels (7 to 10,000 ppb) in compressed gas cylinders in a balance gas of nitrogen. The criteria used for the selection of the gaseous organic compounds is described.

Stability studies indicate that all of the organics tested (with the exception of ethylene oxide and propylene oxide below 10 ppb levels) are stable enough to be used as reliable audit materials.

Subsequent to completion of the stability studies, 196 performance audits have been initiated with the audit materials to assess the accuracy of the Volatile Organic Sampling Train (VOST) and bag measurement methods during or prior to RCRA trial burn tests. The results of those audits and a summary table of the audits conducted for each POHC and the measurement system audited is described in this report. The audit results obtained with the audit gases during or prior to RCRA trial burn tests are generally within ±50 percent of the audit concentrations measured by Research Triangle Institute.

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SECTION 1

INTRODUCTION

Objectives

The determination of POHC at trace levels (< 50 ppb levels) during hazardous waste trial burn tests requires sophisticated sampling and analysis systems. Agency personnel responsible for trial burn tests need to be concerned about the accuracy of POHC measurements. Accuracy of such measurements may be assessed by conducting a performance audit. A performance audit is a quantitative assessment of the accuracy of a measurement system. When a performance audit is conducted during or prior to a hazardous waste trial burn test, it provides an assessment of the measurement accuracy and indicates the presence of any bias for the combined sampling and analysis system.

The Quality Assurance Division of US EPA's Atmospheric Research and Exposure Assessment Laboratory has initiated a program to supply audit materials for use during hazardous waste trial burn tests. The Research Triangle Institute (RTI), under contract with US EPA, is the principal organization for development of audit gases and coordinating subsequent audits using these gases. The main objectives of this program are: (1) to evaluate the quality of measurements made by federal, state/local agencies, or their contractors, by using ppb gas cylinders for performance audits to assess the relative accuracy of source measurement systems during hazardous waste trial burn tests; (2) to verify the manufacturer's certified analysis of the multicomponent gas mixtures; (3) to determine the stability of the gas mixtures over time; and (4) to develop new audit materials as requested by US EPA.

This report describes a summary of the performance audits conducted during or prior to RCRA trial burn tests. Included in the report are: (1) audit materials currently available; (2) the criteria used in selecting organic compounds to develop audit materials; (3) a description of the audit procedure; and (4) currently available RCRA audit results and an example of stability data.

Audit Materials Currently Available

Currently, 27 gaseous compounds selected on the basis of the anticipated needs of US EPA's Office of Solid Waste and Office of Air Quality Planning and Standards have been investigated for suitability as audit materials. Table 1 lists the organic compounds and the concentration ranges currently available in the ppb level cylinder gases. Group I cylinders each contain five (5) compounds; Group II cylinders each contain nine (9) compounds; Group III cylinders each contain seven (7) compounds; and Group IV cylinders each contain six (6) compounds. The audit cylinders fall into three concentration ranges, depending upon the

Table 1. Auditing POHC Measurements*

Group I Compounds	Group II Compounds	Group III Compounds	Group IV Compounds
Carbon tetrachloride	Trichloroethylene	Vinylidene chloride	Acrylonitrile
Chloroform	1,2-dichloroethane	1,1,2-trichloro-1,2,2-trifluoro-ethane (F-113)	1,3-Butadiene
Perchloroethylene	1,2-dibromoethane	1,2-dichloro-1,1,2,2,-tetra-fluoroethane (F-114)	Ethylene oxide**
Vinyl chloride	Acetonitrile	Acetone	Methylene chloride
Benzene	Trichloro-fluoromethane (F-11)	1,4-Dioxane	Propylene oxide**
	Dichloro-difluoromethane (F-12)	Chlorobenzene	O-xylene
	Bromomethane	Toluene	
	Methyl ethyl ketone	Pyridine***	
	1,1,1-trichloro-ethane		

Group I Ranges	Group II Ranges	Group III Ranges	Group IV Ranges
7 to 90 ppb	7 to 90 ppb	7 to 90 ppb	7 to 90 ppb
90 to 430 ppb	90 to 430 ppb	90 to 430 ppb	430 to 10,000 ppb
430 to 10,000 ppb			

*All gas standards are in a balance gas of nitrogen.

**The concentration of this compound in the cylinders in the 7 to 90 ppb range is not certified due to stability problems. Compounds in the 430 to 10,000 ppb range cylinders are found to be stable.

***Concentration not certified due to instability problems.

group to which the cylinder belongs. Each compound in the low concentration range is between 7 and 90 ppb. Group I, II, and III cylinders are available in the intermediate concentration range between 90 and 430 ppb. In addition, Group I and Group IV cylinders are available in a high concentration range between 430 and 10,000 ppb. The balance gas for all gas mixtures is nitrogen, and the cylinder construction material is aluminum.

Criteria Used for Selection of Organic Compounds

In 1983, EPA initiated a program to develop ppb cylinder gas standards containing hazardous organic compounds that could be used to audit volatile POHC measurement systems during trial burn tests. Through 1985, three mixtures of ppb cylinder gases were developed which are shown in Table 1. The criteria used by EPA for selecting various organic compounds in the three mixtures (Groups I, II and III) are described in a separate publication.[1] Briefly, on the basis of experience of EPA's Air and Energy Engineering Research Laboratory (AEERL) with RCRA trial burn testing, five, nine, and seven compound gas standards were developed during 1983 to 1985. Several compounds were included in the same cylinder with the idea that the same gas cylinders could be used to audit more than one POHC during trial burn tests.

In 1986, a six-compound Group IV gas standard was developed. The selection of six organic compounds for Group IV was based on EPA health risk assessment studies plus input from a state agency. The compounds included in Group IV are also shown in Table 1.

Selection of Compound Concentrations for Audit Materials

The gas standards were initially developed at two concentration ranges to audit the two prevalent test methods for volatile POHCs. The 7 to 90 ppb and 90 to 430 ppb concentration ranges were selected to audit POHC measurements during RCRA trial burn tests; the lower range standard is used to audit VOST measurements, and the higher gas standard is used to audit bag sampling measurements. Later, Group I and Group IV standards in the 430 to 10,000 ppb concentration range were added. These standards were added because the RCRA regulation requires a Destruction and Removal Efficiency (DRE) of at least 99.99 percent but does not regulate a maximum emission rate for the POHCs. Therefore, some source testers have received approval to conduct the trial burn test in such a manner that POHC concentrations in stack emissions are about 1000 ppb. Trial burn tests at this higher concentration (i.e., 1000 ppb) reduce considerably the effect of atmospheric POHC contamination on the VOST measurement system, compared to trial burn tests where the POHC stack emissions are in the order of 10 to 50 ppb concentrations.

SECTION 2

PERFORMANCE AUDITS

As stated previously, the EPA (through RTI) supplies cylinder gases containing selected POHCs for audit upon request from the federal, state, or local agencies or their contractors. The contractors must, however, be performing hazardous waste trial burn tests on behalf of EPA or one of these other agencies to qualify for the performance audit. In fact, the VOST method described in the EPA manual SW-846 specifically requires an audit during the trial burn. A performance audit must be conducted simultaneously with the actual planned test. A performance audit prior to a trial burn test to assess the proficiency of the measurement system (including the sampling and analytical personnel) is recommended but not required.

When a request is received, the cylinder pressure is measured and the cylinder is shipped by overland carrier. When a cylinder gas is used to audit the VOST system for a trial burn test, an aluminum suitcase is also sent. The aluminum suitcase contains a gas regulator, a glass manifold with heating tape, and necessary tubing and fittings to draw the cylinder gas sample into the glass manifold. The audit gas is then drawn at atmospheric pressure from the manifold into the VOST system. A schematic of this audit gas delivery system is shown in Appendix A, Figure 1. A letter is included with the audit cylinder which gives general instructions for conducting the audit (see Appendix A). Detailed instructions are shown in Appendix A for conducting an audit of VOST (Instruction No. 3) and bag measurements (Instruction No. 1) during a hazardous waste trial burn. The audit results are reported to the agency (federal, state, or local) coordinator requesting the audit. There is no charge to the user except the cost of returning the audit cylinder and aluminum suitcase. The sampling and analysis methods used by auditees during RCRA audits are summarized in Appendix B. The audit results for each audit initiated are presented in Appendix C.

As of September, 1989, 379 performance audits have been initiated using ppb audit gases. Of these 379 ppb audits, 196 audits have been conducted to assess the accuracy of measurement methods (VOST or bag for sampling and GC/MS or GC with specific detector for analysis) during or prior to hazardous waste trail burn tests. Of the 196 RCRA audits, 179 are complete and the results are summarized in Table 2. For the 179 completed audits, the frequency each compound was selected for audits is shown.

Seven of the 27 compounds have been found to be more popular for performance audits. These seven compounds are: carbon tetrachloride, chloroform, perchloroethylene, vinyl chloride, trichloroethylene, benzene, and toluene. Of the 179 audits completed, 151 are on the VOST, 20 with Tedlar bags, 1 with glass bulbs, and 7 direct injections. The majority of the audits employed GC/MS for analysis and only a few used GC with a specific detector. It is

Table 2. Summary of Audits Performed for RCRA Trial Burns (Through September 1989)

Group I-IV Compounds	Based on 179 Completed Audits				Frequency auditee results within ± 50 percent of audit concentration	
	Frequency compounds selected for audits	Measurement system audited				
		VOST[b]	Bag[c]	Other[d]	VOST	Bag
Carbon tetrachloride	67	56	8	3	48 of 56	7 of 8
Chloroform	34	27	4	3	21 of 27	4 of 4
Perchloroethylene	34	30	4	0	25 of 30	4 of 4
Vinyl chloride	23	21	2	0	14 of 21	2 of 2
Benzene	26	24	2	0	19 of 24	2 of 2
Trichloroethylene	13	12	1	0	10 of 12	1 of 1
1,2-Dichloroethane	11	11	0	0	9 of 11	0 of 0
1,2-Dibromoethane	5	5	0	0	2 of 5	0 of 0
Acetonitrile	3	3	0	0	0 of 3	0 of 0
Trichlorofluoromethane (F-11)	12	10	1	1	6 of 10	1 of 1
Dichlorodifluoromethane (F-12)	6	5	0	1	1 of 5	0 of 0
Bromomethane	4	4	0	0	1 of 4	0 of 0
Methyl ethyl ketone	6	6	0	0	3 of 6	0 of 0
1,1,1-Trichloroethane	9	9	0	0	5 of 9	0 of 0
Vinylidene chloride	3	3	0	0	1 of 3	0 of 0
1,1,2-Trichloro-1,2,2-trifluoroethane (F-113)	5	5	0	0	4 of 5	0 of 0
1,2-Dichloro-1,1,2,2-tetrafluoroethane (F-114)	2	2	0	0	0 of 2	0 of 0
Acetone	2	2	0	0	1 of 2	0 of 0
1,4-Dioxane	2	2	0	0	1 of 2	0 of 0
Toluene	15	12	3	0	7 of 12	3 of 3
Chlorobenzene	14	14	0	0	10 of 14	0 of 0
Acrylonitrile	1	1	0	0	0 of 1	0 of 0
Methylene chloride	5	4	1	0	1 of 4	1 of 1

[a] 196 audits initiated; 179 audits completed; 17 audits currently under way.

[b] GC/MS was used for all VOST analysis.

[c] GC with a specific detector (FID/ECD) was used for bag samples.

[d] "Other" includes direct injection and glass bulbs.

very interesting to note from the table that the auditee results for the VOST method are usually within the ±50 percent accuracy limit stated in the VOST protocol.

The frequency of audits conducted at RCRA trial burn tests on a quarter/calendar year basis since 1984 is shown in Figure 1. It appears from Figure 1 the frequency of audits increased since October 1986, due to the mandatory audit requirement included in the VOST method published in SW 846.[2]

Currently the VOST method has been validated by EPA for carbon tetrachloride, chloroform, perchloroethylene, benzene, and trichlorofluoromethane (F-11).[3] The high frequency of VOST audit results within the ±50 percent accuracy limit suggests that this method may be an effective means of measuring a large number of POHCs in addition to the five compounds validated.

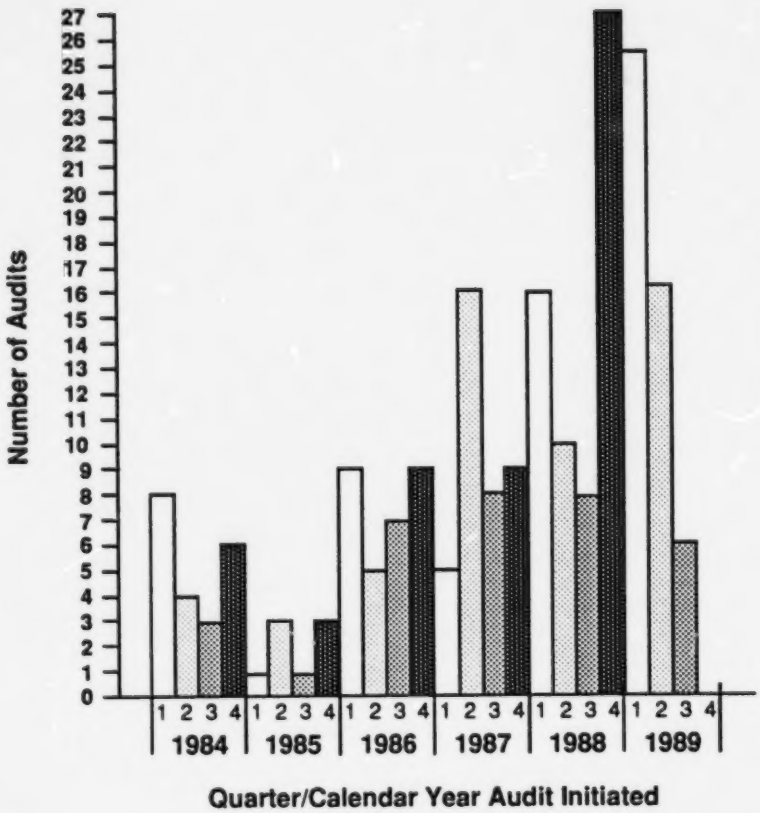

Figure 1. Audits conducted in RCRA trial burns.

SECTION 3

STABILITY STUDIES

An ideal calibration standard or audit material should be stable over its total time of usage. Such standards or materials may be considered stable if the results of reanalyses over time fall within the 95% confidence limits of the combined uncertainty for the preparation and analysis of the analyte concentrations.

To ensure that the concentration of each standard is periodically analyzed for stability, a two-tier stability assessment is conducted. In the first tier, on each standard, the commercial gas manufacturer conducts a minimum of two analyses that are separated by at least 30 days. These analyses were performed to verify that the components in the cylinder were stable at the manufacturing facility before shipment to RTI. The second tier stability assessment involves the periodic reanalysis at RTI. Once a gas standard is received from the gas manufacturer, it is analyzed as soon as possible, then reanalyzed at 2, 6, and 12 months and annually thereafter to determine any change in the gas mixtures. All analyses are performed by using gas chromatography (GC) with flame ionization (FID) and/or electron capture detector (ECD). Currently, National Institute of Standards and Technology (NIST) traceable standards developed and characterized by NIST are being used for calibration and a similar NIST Standard Cylinder mixture is used for Quality Control during all the analyses. The analysis procedures and the stability data obtained to date for all the ppb level organic cylinder gases are summarized and published in a separate report.[4] An example of stability data for a Group I ppb gas standard is shown in Table 3. An examination of the stability data for many of the organics in the ppb level cylinder gases shows the results varied by less than 10 percent over a 1- to 5-year period. A gas standard is not available for auditing purposes until the 2-month RTI analysis is completed. If the compounds are not stable during that period, those compounds are not recommended for audits. It appears from the long-term stability study that all the organics tested (with the exception of ethylene oxide and propylene oxide at 10 ppb level) are stable enough to be used as reliable audit materials.

**TABLE 3. STABILITY STUDY FOR GROUP I COMPOUNDS*
CYLINDER I-A2**

ACTIVITY		COMPOUND				
		Carbon tetra-chloride	Chloroform	Perchloro-ethylene	Benzene	Vinyl chloride
MANUFACTURER ANALYSIS						
Theoretical	ppb	(9.50)	(39.6)	(9.40)	(18.9)	(20.0)
1st Analysis Date		11/17/83	11/17/83	11/17/83	12/06/83	12/06/83
	ppb	(7.70)	(42.1)	(9.20)	(15.8)	(18.3)
2nd Analysis Date		12/16/83	12/16/83	12/16/83	12/15/83	12/15/83
	ppb	(7.10)	(41.2)	(7.70)	(19.6)	(19.2)
RTI ANALYSIS**						
1st RTI Analysis Date		1/06/84	1/06/84	1/06/84	1/23/84	1/23/84
	ppb	(9.30 ± 0.3)	(40.0 ± 0.8)	(9.40 ± 0.2)	(19.6 ± 0.6)	(20.2 ± 0.6)
2nd RTI Analysis Day***		59	59	59	49	49
	ppb	(9.30 ± 0.3)	(38.7 ± 0.8)	(10.3 ± 0.2)	(20.0 ± 0.6)	(19.0 ± 0.6)
3rd RTI Analysis Day***		238	238	238	226	226
	ppb	(9.50 ± 0.3)	(40.6 ± 0.9)	(9.50 ± 0.2)	(19.4 ± 0.6)	(20.6 ± 0.7)
4th RTI Analysis Day***		404	404	404	375	375
	ppb	(9.60 ± 0.3)	(37.1 ± 0.8)	(9.10 ± 0.2)	(19.4 ± 0.6)	(20.4 ± 0.7)
5th RTI Analysis Day***						
	ppb	on audit	on audit	on audit	on audit	on audit
6th RTI Analysis Day***		833	833	833	810	810
	ppb	(10.5 ± 0.3)	(40.5 ± 0.9)	(11.2 ± 0.3)	(19.7 ± 0.6)	(19.4 ± 0.6)
7th RTI Analysis Day***		1337	1337	1337	1337	1337
	ppb	(9.45 ± 0.3)	(40.6 ± 0.9)	(10.1 ± 0.3)	(19.2 ± 0.6)	(20.1 ± 0.6)
8th RTI Analysis Day***		1699	1699	1699	1682	1682
	ppb	(9.36 ± 1.9)	(44.2 ± 4.0)	(9.65 ± 1.2)	(18.3 ± 2.1)	(19.3 ± 2.4)
9th RTI Analysis Day***		1875	1875	1875	1858	1858
	ppb	(9.26 ± 0.8)	(40.5 ± 2.5)	(9.43 ± 0.6)	(18.5 ± 1.3)	(19.6 ± 1.5)
RTI QUALITY CONTROL+						
1st RTI Analysis Date		1/06/84	1/06/84	1/06/84	1/23/84	1/23/84
	ppb	(20.6 ± 0.6)	(22.8 ± 0.5)	(31.7 ± 0.8)	(17.5 ± 0.6)	(14.3 ± 0.5)
NIST Concentration						
	ppb	(21.0 ± 1.0)	(23.0 ± 1.0)	(29.0 ± 2.0)	(17.0 ± 1.0)	(15.0 ± 1.0)
2nd RTI Analysis Day		59	59	59	49	49
	ppb	(20.3 ± 0.6)	(8.90 ± 0.2)	(23.6 ± 0.6)	(18.6 ± 0.6)	(15.0 ± 0.5)
NIST Concentration						
	ppb	(19.0 ± 1.0)	(9.00 ± 1.0)	(22.0 ± 1.0)	(17.0 ± 1.0)	(15.0 ± 1.0)

(continued)

TABLE 3. STABILITY STUDY FOR GROUP I COMPOUNDS* (continued)
CYLINDER I-A2

ACTIVITY	COMPOUND				
	Carbon tetra-chloride	Chloroform	Perchloro-ethylene	Benzene	Vinyl chloride
	RTI QUALITY CONTROL +				
3rd RTI Analysis Day	238	238	238	226	226
ppb	(21.1 ± 0.6)	(24.3 ± 0.5)	(29.5 ± 0.7)	(19.0 ± 0.6)	(15.3 ± 0.5)
NIST Concentration ppb	(21.0 ± 1.0)	(23.0 ± 1.0)	(29.0 ± 2.0)	(17.0 ± 1.0)	(15.0 ± 1.0)
4th RTI Analysis Day	404	404	404	375	375
ppb	(20.6 ± 0.6)	(23.2 ± 0.5)	(28.7 ± 0.7)	(18.1 ± 0.6)	(14.1 ± 0.5)
NIST Concentration ppb	(21.0 ± 1.0)	(23.0 ± 1.0)	(29.0 ± 2.0)	(17.0 ± 1.0)	(15.0 ± 1.0)
5th RTI Analysis Day	497	497	497	508	508
ppb	(19.9 ± 0.6)	(22.9 ± 0.5)	(28.8 ± 0.7)	(18.5 ± 0.6)	(15.2 ± 0.5)
NIST Concentration ppb	(21.0 ± 1.0)	(23.0 ± 1.0)	(29.0 ± 2.0)	(17.0 ± 1.0)	(15.0 ± 1.0)
6th RTI Analysis Day	833	833	833	810	810
ppb	(22.4 ± 0.7)	(25.5 ± 0.5)	(32.7 ± 0.8)	(16.9 ± 0.5)	(14.7 ± 0.5)
NIST Concentration ppb	(21.0 ± 1.0)	(23.0 ± 1.0)	(29.0 ± 2.0)	(17.0 ± 1.0)	(15.0 ± 1.0)
7th RTI Analysis Day	1337	1337	1337	1337	1337
ppb	(18.7 ± 0.9)	(9.80 ± 0.4)	(23.0 ± 0.6)	(17.3 ± 0.5)	(16.6 ± 0.6)
NIST Concentration ppb	(19.3 ± 1.0)	(9.60 ± 0.2)	(22.8 ± 0.2)	(16.8 ± 0.5)	(16.1 ± 1.0)
8th RTI Analysis Day	1699	1699	1699	1682	1682
ppb	(10.9 ± 1.9)	(10.6 ± 0.9)	(13.5 ± 1.1)	(9.96 ± 1.0)	(15.4 ± 1.8)
NIST Concentration ppb	(10.8 ± 0.5)	(10.1 ± 0.5)	(13.0 ± 0.7)	(10.10 ± 0.5)	(15.1 ± 0.7)
9th RTI Analysis Day	1875	1875	1875	1858	1858
ppb	(10.9 ± 0.8)	(9.73 ± 0.6)	(13.1 ± 1.1)	(9.86 ± 0.7)	(15.0 ± 1.1)
NIST Concentration ppb	(11.0 ± 0.5)	(9.60 ± 0.5)	(13.3 ± 0.5)	(10.0 ± 0.5)	(15.7 ± 0.7)

* An NIST primary standard was used for calibration for 7th RTI analysis. Permeation tubes were used for calibration for all previous analyses.

** Seventh analysis was performed by automated cryogenic preconcentration with cryofocusing followed by GC/FID. Previous analyses were performed by direct injection.

*** Number of days after 1st RTI analysis date.

\+ An NIST primary standard was used as internal quality control on each day of RTI analysis.

SECTION 4

SUMMARY AND CONCLUSIONS

Compressed gas cylinders containing 27 gaseous volatile organic compounds at parts-per-billion levels have been used successfully in audits to assess the accuracy of measurement systems, especially those used during hazardous waste trial burn tests The 27 gaseous volatile organic compounds were selected on the basis of the anticipated needs of US EPA's Office of Solid Waste and Office of Air Quality Planning and Standards. One compound, pyridine, was not certified due to analytical problems.

Stability studies indicate that all of the organic compounds tested (with the exception of ethylene oxide and propylene oxide at the 10 ppb level) are stable enough to be used as reliable audit materials. One hundred-ninety-six performance audits have been initiated (through September 1989) to assess the accuracy of POHC measurement systems used during hazardous waste trial burn tests. Audit results have generally been within ±50 percent of the RTI measured concentrations.

SECTION 5

REFERENCES

1. D. J. von Lehmden, "Program Strategies for Standards Development for Hazardous Waste Incineration," presented at the ASTM Conference on Recent Developments in Monitoring Methods for Toxics in the Atmosphere, July 27-31, 1987, Boulder, Colorado.

2. Volatile Organic Sampling Train, Method 0030. SW-846 Manual (Test Methods for Evaluating Solid Waste, Physical/Chemical Methods), 3rd Edition, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, Document Number 955-001-00000-1.

3. R. G. Fuerst, T. J. Logan, M. R. Midgett, and J. Prohaska, "Validation Studies of the Protocol for the Volatile Organic Sampling Train," *J. Air Pollution Control Association*, Vol. 37, No. 4, pp. 388-94, April 1987.

4. V. R. Bryant, G. B. Howe, S. B. Tompkins, and R. K M. Jayanty, "Stability of Parts-Per-Billion Hazardous Organic Cylinder Gases and Performance Audit Results of Source Test and Ambient Air Measurement Systems," Status Report #6, Research Triangle Institute, October 1989.

Appendix A

Audit Instructions

MEMORANDUM

To: Date:

From: Shonna Tompkins, RTI

This suitcase kit is provided in conjunction with audit gas cylinder(s) which are arriving simultaneously via Overnite Transportation Company.

A letter accompanying the audit cylinder(s) describes their purpose and origin.

The audit gas from the cylinder running through the kit's manifold simulates the ambient emission from the stack through your probe. Follow instructions attached to use the kit materials for your audit.

Please return the suitcase **in its shipping box**, at your cost, through United Parcel Service (UPS). I have included an address label for the outside of the box.

Insure the suitcase kit for $1000 (only a $2.25 charge).

Thank you!

VOST AUDIT KIT INVENTORY

QTY	DESCRIPTION
1	GLASS MANIFOLD with Teflon® nut and ferrule on one end
1	HEATING TAPE (wrapped around manifold)
1	1/8" TEFLON TUBING (about 3 feet) with: 1/4 to 1/8" brass Swagelock™ union, one end 1/4" brass Swagelock nut, other end
1	REGULATOR, 2 stage, high purity, 350 GCA fitting, with female connector
1	3/8" TEFLON TUBING, "SHORT" with: 3/8" brass Swagelock nut
1	ROTAMETER, 3/8" Swagelock female connectors on both ends
1	3/8" TEFLON TUBING, "LONG" with: 3/8" brass Swagelock nut
1	THERMOMETER, DIAL FACE, 8", 0-150°C
2	TWO-PRONG EXTENSION CLAMPS, 8"
2	RIGHT-ANGLE CLAMP HOLDERS, aluminum thumbscrew type
1	BASE SUPPORT, 4" x 6"
1	ROD FOR BASE SUPPORT, 5/16" diameter, 18" long
1	CYLINDER CLAMP SUPPORT WITH NYLON STRAP
1	HEATER CONTROLLER, for connection to heating tape
1	INSTRUCTION SHEET

Please notify me at once if an item is missing or defective.

Thank you for CAREFULLY repackaging all items.

Shonna Tompkins
(919) 541-7023

INSTRUCTIONS FOR USE OF VOST AUDIT KIT

1. Assemble the support stand (base and rod). Using the clamps supplied, secure the manifold and rotameter vertically to the stand. The **larger** end of the manifold should be **temporarily** up, so the thermometer can be inserted.

2. Connect the heating controller to the tape and adjust the dial to heat the manifold to approximately 100°C.

   On assemblies with 1" tape (closely wrapped), a setting of 5 is sufficient to attain 100°C.

   On assemblies with 1/2" tape (loosely wrapped), a setting of 7-1/2 is required.

3. After the manifold temperature has become stable, remove the thermometer, invert the manifold (larger end down) and attach the shorter 3/8" OD tubing by sliding the end sleeve-wise over the glass.

4. Attach the 1/8" tubing (union end) to the Teflon nut on the top of the manifold. The 3/8" Swagelock nut-end connects to the regulator at the reduced-end fitting.

5. Consult diagram for attaching rotameter, longer exhaust tubing, and audit cylinder.

6. Adjust the regulator to start the gas flow. The audit kit-supplied rotameter is downstream of the manifold and is used to monitor **excess** gas flow.

7. The rotameter will present negligible back pressure to the manifold. ΔP for 5 L/min is 1 inch of water column.

8. After sampling is completed, allow the manifold to cool, disassemble and repackage the audit kit into the case. Remember to include the teflon nut on the end of the manifold. The tubing can lie flat on top of the repackaged kit, loosely coiled.

9. Ship the case inside the box it came in, by United Parcel Service (UPS).

INSTRUCTION SET NO. 1

INSTRUCTIONS FOR THE SAMPLING AND ANALYSIS OF VOLATILE POHC FROM QUALITY ASSURANCE AUDIT CYLINDERS USING THE BAG TECHNIQUE

1.0 PURPOSE

This audit is intended to assess and document the accuracy and precision of the principle organic hazardous constituents (POHC) using the bag technique during trial burns at hazardous waste burning facilities. This audit also can be used to determine the proficiency of source testing organization prior to the actual trial burn tests.

2.0 PRINCIPLE

A gas sample containing POHC is drawn from an audit gas cylinder into a bag. The collected POHC are analyzed by gas chromatography according to the method specifications and procedures.

3.0 AUDIT MATERIAL (GAS CYLINDERS)

The audit material is contained in gas cylinders. A maximum of 5 L of audit gas is to be used for each test run. A two-stage gas regulator, 1/4-inch male/female glass joints, and Teflon tubing are supplied for use with the gas cylinder.

4.0 PROCEDURES

The following step-by-step procedures should be used for sample collection and analysis using the bag technique.

Step A. Evacuate the bag with a vacuum pump and fill the bag with approximately 5 L of organic-free nitrogen from a gas cylinder. Tedlar® bags are recommended. Determine the hazardous constituents of interest by gas chromatography. Report the concentrations determined as Blank Value 1. The blank value must be not more than twice the detection limit. If it is higher, the bag cleaning procedure should be repeated.

Step B. After the blank analysis, evacuate the bag with a vacuum pump and fill the bag with approximately 5 L of audit gas from the audit cylinder. The 1/4-inch male/female glass joints that are supplied should be used as connections to the bag and the audit cylinder. Minimum Teflon tubing should be used. Determine the POHC of interest by gas chromatography. Report the concentrations of each constituent as Analysis Result 1.

Step C. Evacuate the bag contents and fill the bag with organic free nitrogen (Cleaning Step 1). After 3 minutes, evacuate the bag contents and fill the bag again with nitrogen (Cleaning Step 2). After three minutes, repeat the

evacuation procedure and fill the bag with 5 L of nitrogen (Blank 2). Determine the concentration of the bag contents by gas chromatography and report the measured concentration as Blank Value 2. The blank value must not be more than twice the detection limit. If it is higher, the bag cleaning procedure should be repeated.

Step D. Evacuate the bag contents and fill the bag with approximately 5 L of audit gas from the audit cylinder. Determine the POHC of interest by gas chromatography. Report the concentrations determined as Analysis Result 2.

Step E. Repeat Step C and report the measured concentration of the bag contents as Blank Value 3. The blank value must not be more than twice the detection limit. If it is higher, the bag cleaning procedures should be repeated.

Step F. Evacuate the bag contents and fill the bag with approximately 5 L of audit gas from the audit cylinder. Determine the POHC of interest by gas chromatography. Report the concentrations determined as Analysis Result 3.

5.0 SAMPLE ANALYSIS

Follow the procedures described in the method used for sample analysis, calibration, and calculations. Submit the results to the Project Officer and to the audit supervisor for evaluation.

INSTRUCTION SET NO. 3

INSTRUCTIONS FOR THE SAMPLING AND ANALYSIS OF VOLATILE POHC FROM QUALITY ASSURANCE AUDIT CYLINDERS USING THE VOLATILE ORGANIC SAMPLING TRAIN

1.0 PURPOSE

This audit is intended to assess and document the accuracy and precision of the volatile organic sampling train (VOST) when used during trial burns at hazardous waste burning facilities. This audit also can be used to determine the proficiency of source testing organization prior to the actual trial burn tests.

2.0 PRINCIPLE

A gas sample containing principal organic hazardous constituents (POHC) is passed from an audit gas cylinder into a glass manifold and is used in place of the test site stack sample. While the POHC gas is being passed into the glass manifold, a major portion of the gas is drawn through a VOST according to the method specifications and procedures. The collected POHC are analyzed by thermal desorption, purge and trap, and gas chromatography/mass spectrometry (GC/MS) or an equivalent method approved by the EPA.

3.0 APPARATUS

3.1 GLASS MANIFOLD

A glass manifold is supplied. One side of the glass manifold is connected with Teflon tubing to the audit cylinder. The other end of the glass manifold should be connected with Teflon tubing to a rotameter and the excess gas from the rotameter should be vented into a hood. The glass manifold is heated to 100°C with heating tape. The heating tape, rotameter, 1/4-inch male/female glass joints, and Teflon tubing are also supplied. One port of the glass manifold should be connected to the VOST probe with 1/4-inch male/female glass joints. A schematic diagram of the glass manifold is shown in Figure 1.

3.2 VOST COMPONENTS

The sampling train component parts, except for the glass manifold, are the same as those used for VOST.

3.3 ANALYSIS

Refer to the method specifications and procedures for the VOST method.

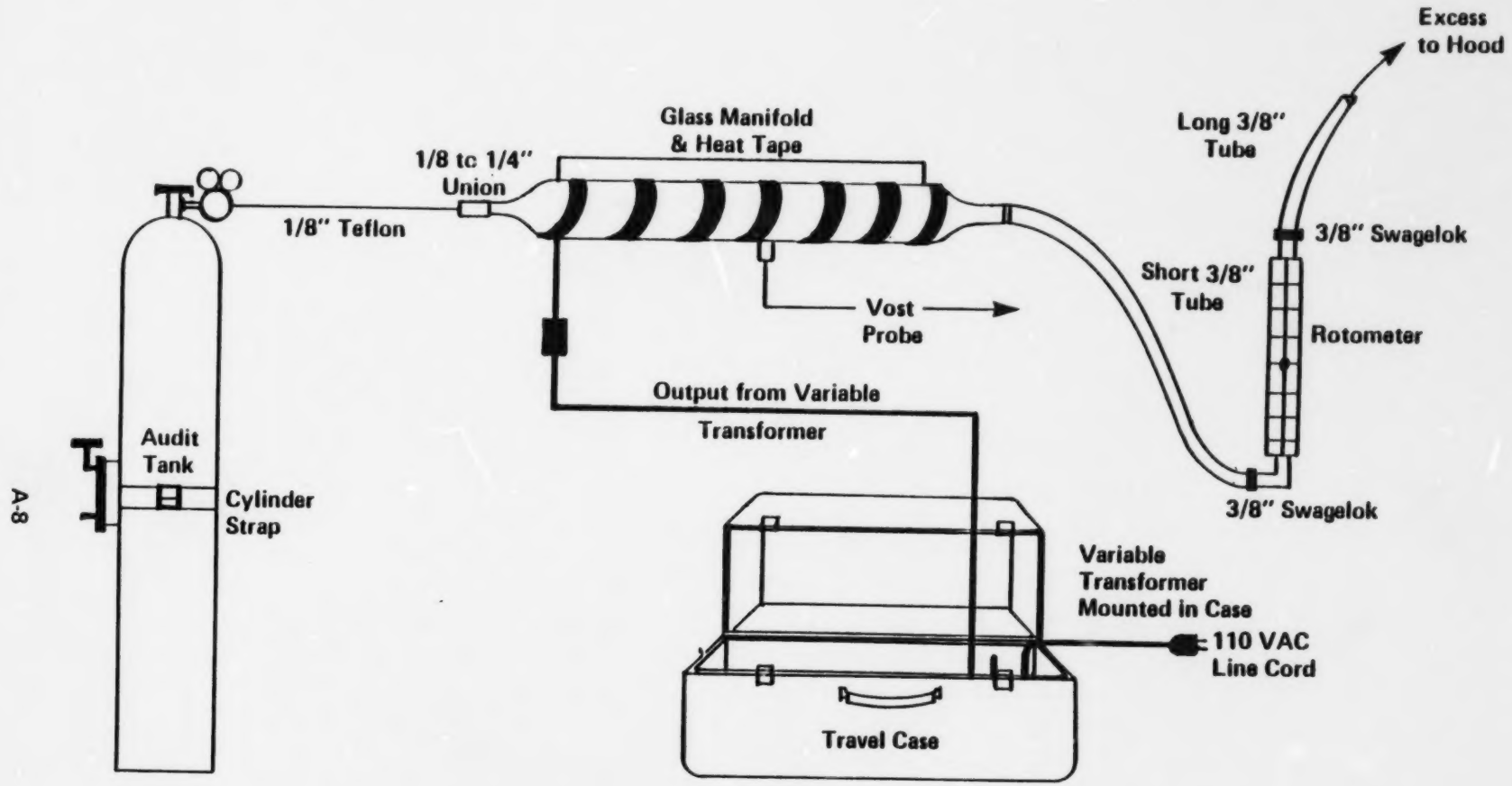

Figure 1. Schematic diagram of audit material delivery system.

4.0 AUDIT MATERIAL (GAS CYLINDERS)

The audit material is supplied in gas cylinders. A maximum of 50 L of gas is to be used for each test run. A two-stage gas regulator is supplied for use with the gas cylinder.

5.0 PROCEDURES

5.1 SAMPLING

5.1.1 Preparation of VOST

All train components should be cleaned and assembled as described in the VOST method used.

5.1.2 Leak-Check Procedure

Before the sampling run, the train is leak-checked as described in the VOST method. During sampling, all connections should be visually examined.

5.1.3 Sample Generation

The gas sample from the audit cylinder is passed through the glass manifold at a flow rate of 2 L/min for 3 minutes to condition the glass system. A glass rotameter is supplied to measure the flow rate at the end of the glass manifold. The VOST probe then should be connected to one port of the glass manifold with 1/4 inch male/female joints and the probe should be purged with audit gas for an additional 2 minutes so that the probe is purged of ambient air before initiation of sample collection. This can be accomplished either by attaching a pump to a three-way stop-cock above the first condenser and drawing audit gas through the probe via the three-way stop-cock or by any other suitable method.

5.2 SAMPLE COLLECTION

After leak-checking and conditioning the glass probe, sample collection is accomplished by opening the valve at the inlet to the first condenser, turning on the pump and sampling at a rate of 0.5 L/min for 20 minutes or 1 L/min for 10 minutes. The sampling rate is measured with the rotameter which is part of the VOST. The volume of sample for any pair of the traps should not exceed 10 L. The temperature of the gas stream at the inlet to the first sorbent cartridge must be maintained at 20°C during sample collection.

After the collection of 10 L of sample, the train is leak-tested using the procedures described in the method used. If leak-test criteria as described in the method are not met, the samples should not be analyzed. If leak-test criteria are met, the train is returned to atmospheric pressure, the two sorbent cartridges are removed, the end caps are replaced, and analysis of cartridges is performed.

Repeat the sample collection procedure two more times with two new pairs of sample cartridges in the VOST, collect 10 L of sample each time, and perform the analysis.

5.3 SAMPLE ANALYSIS

Follow the procedures described in the method for sample analysis, calibration, and calculations. Report the amount of each constituent in the three samples and the blank values to the Project Officer and the audit supervisor for evaluation.

APPENDIX B

SUMMARY OF SAMPLING AND ANALYSIS METHODS USED DURING PERFORMANCE AUDITS

Summary of Sampling and Analysis Methods Used During Performance Audits

Audit No.	Client*	Use of audit material	Measurement system audited
1A	A	VOST method evaluation	Sampling by VOST method Analysis by GC/MS
1B	A	BAG method evaluation (RCRA testing)	Sampling by BAG Analysis by GC/FID-ECD
2A	B	VOST method evaluation	Sampling by VOST method Analysis by GC/MS
2B	B	BAG method evaluation (RCRA testing)	Sampling by BAG Analysis by GC/ECD-PID
3	C	VOST method evaluation	Sampling by VOST Analysis by GC/PID-Hall Detector
4	D	VOST method evaluation	Sampling by VOST Analysis by GC/MS
5	Region V U.S. EPA	Hazardous waste incineration trial burn analysis evaluation	Sampling by VOST Analysis by GC/MS
6	Combustion Research Facility U.S. EPA	VOST method evaluation	Sampling by VOST Analysis by GC/MS
7	E	Hazardous waste incineration burn analysis evaluation	Direct analysis by GC/ECD
8	F	VOST method evaluation	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
11	B	VOST method evaluation	Sampling by VOST Analysis by GC/MS
12	B	VOST method evaluation	Sampling by VOST Analysis by GC/MS
13	E	Hazardous waste incineration trial burn analysis evaluation	Direct analysis by GC/ECD
14	E	Hazardous waste incineration trial burn analysis evaluation	Direct analysis by GC/ECD
17	H	Hazardous waste incineration trial burn	Sampling by VOST Analysis by GC/MS
19	B	Hazardous waste incineration trial burn	Sampling by VOST Analysis by GC/MS
20	J	Hazardous waste incineration trial burn	Direct analysis by MS/MS
21	K	Hazardous waste incineration trial burn	Sampling method unknown Analysis by GC/ECD or FID
22	L	Hazardous waste incineration trial burn	Sampling by VOST Analysis by GC/MS
26	N	Hazardous waste incineration trial burn	Sampling by glass bulb Analysis by GC/Hall detector
28	O	Hazardous waste incineration trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
29	B	Hazardous waste incineration sampling method evaluation	Sampling by VOST Analysis by GC/MS
32	B	Hazardous waste incineration sampling method evaluation	Sampling by VOST Analysis by GC/MS
33	B	Hazardous waste incineration sampling method evaluation	Sampling by VOST Analysis by GC/MS
37	S	Hazardous waste incineration VOST method evaluation	Sampling by VOST Analysis by GC/FID
44	U	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
45	U	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
47	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
53	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
68	Z	Hazardous waste trial burn	Sampling into Tedlar bags Analysis by GC/ECD
69	Z	Hazardous waste trial burn	Sampling by VOST Analysis by GC/ECD
70	AA	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
71	HH	Hazardous waste incineration	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
72	HH	Hazardous waste incineration (boiler)	Sampling by VOST Analysis by GC/MS
73	HH	Hazardous waste incineration (boiler)	Sampling by VOST Analysis by GC/MS
79	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
80	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
81	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
82	CC	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
86	EE	Hazardous waste trial burn	Sampling by VOST Analysis by GC/ECD
88	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/ECD
89	Z	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/ECD
90	Z	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/ECD
91	LL	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
92	LL	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
93	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
94	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
95	MM	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
96	VV & NN	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
97	VV & NN	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
101	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
102	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
103	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
104	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
105	PP	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
107	HH	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/ECD
108	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
109	QQ	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/FID
110	QQ	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/FID
112	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
113	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
116	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
121	XX	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/ECD
122	XX	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/FID
124	YY	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
125	YY	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
127	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
131	H	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/MS
132	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
137	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
138	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
139	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
142	Q	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
143	AC	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
144	VV	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
145	VV	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
149	A	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
150	A	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
153	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
154	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
159	AF	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
160	AJ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
161	AG	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
162	AG	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
170	AK	Hazardous waste trial burn	Sampling by direct injection Analysis by GC/ECD
171	AK	Hazardous waste trial burn	Sampling by direct injection Analysis by GC/ECD
178	AM	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/MS
179	AM	Hazardous waste trial burn	Sampling by Tedlar bag Analysis by GC/MS
180	QQ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
181	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
184	A	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
185	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
186	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
188	QQ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
189	AN	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
190	AN	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
198	AD	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
199	AO	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
200	AO	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
202	AP	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
203	AK	Hazardous waste trial burn	Sampling by bag Analysis by GC/ECD
204	AK	Hazardous waste trial burn	Sampling by bag Analysis by GC/ECD
205	AA	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
206	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
207	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
208	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
218	AT	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
219	AT	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
220	AT	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
221	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
222	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
224	AG	Hazarous waste trial burn	Sampling by VOST Analysis by GC/MS
226	AU	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
235	PP	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
236	AA	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
239	AD	Hazardous waste trial burn	Sampling by VOST/Modified Method 5 Analysis by GC/MS
241	VV	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
247	AY	Hazardous waste trial burn	Sampling by VOST Analysis by Method 8240
248	AP	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
252	KK	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
253	KK	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
258	BD	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
259	BD	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
260	BE	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
261	AA	Hazardous waste trial burn	Sampling by Method 18, Tedlar bag sampling Analysis by GC/selective detector
262	BE	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
263	BE	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
265	BI	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
268	BF	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
269	BI	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
270	BH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
271	BH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
272	BJ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
273	BK	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
274	BL	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
277	BM	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
278	BM	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
279	BM	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
280	BO	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
281	BP	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
284	AA	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
285	AA	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
286	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
287	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
288	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
289	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
290	BR	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
291	BR	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
292	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
293	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
294	BJ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
295	BJ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
296	BS	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
302	DD	Hazardous waste trial burn	Sampling by Tedlar Bags Analysis by GC/FID
303	DD	Hazardous waste trial burn	Sampling by Tedlar Bags Analysis by GC/FID
310	BU	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
311	BU	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
313	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
314	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
315	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
316	A	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
317	A	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
318	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
319	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
320	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
321	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
322	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
323	HH	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
324	BJ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
325	BJ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
326	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
327	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
328	AD	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
329	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
332	BJ	Hazardous waste trial burn	Sampling by Tedlar Bag Analysis by GC/MS
333	BJ	Hazardous waste trial burn	Sampling by Tedlar Bag Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
334	BW	Hazardous waste trial burn	Sampling by Tedlar Bag Analysis by GC/MS
338	W	Hazardous waste trial burn	Sampling by Tedlar Bag Analysis by GC/MS
339	AU	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
340	AU	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
341	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
342	S	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
343	S	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
345	BX	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
346	BX	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
348	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
349	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
350	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
352	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
354	BX	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
355	BZ	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
356	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
357	O	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
358	AD	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
359	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
360	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
367	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
368	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
371	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
372	W	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

(continued)

Summary of Sampling and Analysis Methods Used During Performance Audits (Continued)

Audit No.	Client*	Use of audit material	Measurement system audited
374	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS
375	H	Hazardous waste trial burn	Sampling by VOST Analysis by GC/MS

*Whenever the auditee is known, an alphabetical letter is shown. Whenever the auditee is unknown, the name of the agency requesting the audit is shown.

APPENDIX C

SUMMARY OF PERFORMANCE AUDIT RESULTS

Summary of Performance Audit Results

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
1A	A	VOST method evaluation	Carbon Tetrachloride	21.0 ± 1.0	-50	B
			Chloroform	23.0 ± 1.0	0	
			Perchloroethylene	29.0 ± 2.0	+17	
			Benzene	18.0 ± 1.0	+31	
			Vinyl Chloride	31.0 ± 1.0	-50	
1B	A	BAG method evaluation (RCRA Testing)	Carbon Tetrachloride	141 ± 3.0	+60	B
			Chloroform	120 ± 3.0	+34	
			Perchloroethylene	126 ± 3.0	+31	
			Benzene	133 ± 3.0	+18	
			Vinyl Chloride	154 ± 3.0	-33	
2A	B	VOST method evaluation	Carbon Tetrachloride	21.0 ± 1.0	+27	B
			Chloroform	23.0 ± 1.0	+28	
			Perchloroethylene	29.0 ± 2.0	+34	
			Benzene	18.0 ± 1.0	+32	
			Vinyl Chloride	31.0 ± 1.0	-66	
2B	B	BAG method evaluation (RCRA Testing)	Carbon Tetrachloride	141 ± 3.0	-13	B
			Chloroform	120 ± 3.0	-16	
			Perchloroethylene	126 ± 3.0	-44	
			Benzene	133 ± 3.0	-27	
			Vinyl Chloride	154 ± 3.0	-34	
3	C	VOST method evaluation	Carbon Tetrachloride	21.0 ± 1.0	+10	B
			Chloroform	23.0 ± 1.0	+20	
			Benzene	18.0 ± 1.0	-9	
4	D	VOST method evaluation	Carbon Tetrachloride	21.0 ± 1.0	-14	B
			Chloroform	23.0 ± 1.0	-20	
			Perchloroethylene	29.0 ± 2.0	+17	
			Benzene	18.0 ± 1.0	+6	
			Vinyl Chloride	31.0 ± 1.0	-10	

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
5	Region V U.S. EPA	Hazardous waste incineration trial burn analysis evaluation	Carbon Tetrachloride Chloroform Vinyl Chloride	11.0 ± 0.3 45.0 ± 0.9 20.5 ± 0.7	-31 +200 +7	B
6	Combustion Research Facility U.S. EPA	VOST method evaluation	Carbon Tetrachloride Chloroform Perchloroethylene Benzene	9.9 ± 0.3 42.0 ± 0.9 9.6 ± 0.2 20.0 ± 0.6	+22 0 +40 +3	B
7	E	Hazardous waste incineration burn analysis evaluation	Carbon Tetrachloride Chloroform	11.8 ± 0.4 10.5 ± 0.2	-3 +86	B
8	F	VOST method evaluation	Group I	7 - 90	NA	C
11	B	VOST method evaluation	Carbon Tetrachloride Chloroform Perchloroethylene Benzene Vinyl Chloride	11.0 ± 0.3 47.4 ± 1.0 11.3 ± 0.3 25.2 ± 0.8 19.8 ± 0.6	+5 +3 +5 -7 -85	B
12	B	VOST method evaluation	Carbon Tetrachloride Chloroform Perchloroethylene Benzene Vinyl Chloride	6.6 ± 0.2 7.4 ± 0.2 21.9 ± 0.5 26.0 ± 0.8 29.6 ± 0.9	+21 +12 +56 +47 -52	B
13	E	Hazardous waste trial burn analysis evaluation	Carbon Tetrachloride Chloroform	11.6 ± 0.4 10.2 ± 0.2	+11 +100	B
14	E	Hazardous waste trial burn analysis evaluation	Carbon Tetrachloride Chloroform	24.0 ± 0.7 16.0 ± 0.3	-25 +31	B

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
17	H	Hazardous waste trial burn	Carbon Tetrachloride	9.9 ± 0.3	-19	B
			Chloroform	42.0 ± 0.9	-32	
			Perchloroethylene	9.6 ± 0.2	-14	
			Benzene	20.0 ± 0.6	-21	
			Vinyl Chloride	19.8 ± 0.6	-41	
19	B	Hazardous waste trial burn	Carbon Tetrachloride	11.6 ± 0.3	+28	B
20	J	Hazardous waste trial burn	Group I	7 - 90	NA	C
21	K	Hazardous waste trial burn	Group I	7 - 90	NA	C
22	L	Hazardous waste trial burn	Carbon Tetrachloride	12.7 ± 0.4	-21	B
			Chloroform	12.3 ± 0.3	-27	
			Perchloroethylene	62.2 ± 1.5	-44	
			Benzene	48.0 ± 1.5	-63	
			Vinyl Chloride	31.3 ± 1.0	-81	
26	N	Hazardous waste trial burn	Trichlorofluoromethane	15.4 ± 0.5	-42	B
			Dichlorodifluoromethane	16.6 ± 0.7	-10	
28	O	Hazardous waste trial burn	Carbon Tetrachloride	9.5 ± 0.3	+22	B
			Chloroform	40.6 ± 0.9	+9	
			Perchloroethylene	9.5 ± 0.2	+16	
			Benzene	19.4 ± 0.6	+17	
			Vinyl Chloride	20.6 ± 0.7	-13	
29	B	Hazardous waste incineration sampling method evaluation	Carbon Tetrachloride	11.4 ± 0.3	+5	B
			Chloroform	43.9 ± 0.9	+8	
			Perchloroethylene	10.3 ± 0.2	+20	
			Benzene	19.9 ± 0.6	+23	

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
32	B	Hazardous waste incineration sampling method evaluation	Carbon Tetrachloride Chloroform Perchloroethylene Benzene	9.6 ± 0.3 37.1 ± 0.8 9.1 ± 0.2 19.4 ± 0.6	-1 +11 -18 +7	B
33	B	Hazardous waste incineration sampling method evaluation	Carbon Tetrachloride Chloroform Perchloroethylene Benzene	37.7 ± 1.1 8.3 ± 0.2 8.4 ± 0.2 40.7 ± 1.3	-25 -24 -17 -26	B
37	S	Hazardous waste incineration sampling method evaluation	Acetonitrile Trichloroethylene Trichlorofluoromethane 1,2-Dibromoethane 1,1,1-Trichloroethane	7.9 ± 0.6 9.0 ± 0.4 9.4 ± 0.3 10.2 ± 0.4 10.1 ± 0.5	+377 +39 +3 +1 +7	B
44	U	Hazardous waste trial burn	Carbon Tetrachloride Chloroform Perchloroethylene Benzene	11.4 ± 0.3 43.9 ± 0.9 10.3 ± 0.2 19.9 ± 0.6	-68 -25 +8 -20	B
45	U	Hazardous waste trial burn	Group II	7 - 90	NA	C
47	H	Hazardous waste trial burn	Group III	7 - 90	NA	C
53	W	Hazardous waste incineration trial burn	Carbon Tetrachloride	12.3 ± 0.4	+24	B
68	Z	Hazardous waste trial burn	Carbon Tetrachloride Chloroform	12.3 ± 0.4 12.2 ± 0.3	-43 +15	B
69	Z	Hazardous waste trial burn	Trichloroethylene	9.6 ± 0.5	-6	B

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
70	AA	Hazardous waste trial burn	Trichloroethylene	15.1 ± 0.7	+92	B
			1,2-Dichloroethane	15.8 ± 0.8	+27	
			Trichlorofluoromethane	16.2 ± 0.5	-26	
			Bromomethane	14.0 ± 0.5	-57	
			Dichlorodifluoromethane	16.0 ± 0.7	+256	
			1,1,1-Trichloroethane	14.0 ± 0.7	+71	
71	HH	Hazardous waste incineration (boiler)	Carbon Tetrachloride	6.4 ± 0.2	+30	B
72	HH	Hazardous waste incineration (boiler)	1,1,1-Trichloroethane	13.3 ± 0.7	+31	B
73	HH	Hazardous waste incineration (boiler)	Toluene	10.3 ± 1.3	+21	B
79	H	Hazardous waste trial burn	Carbon Tetrachloride	6.4 ± 0.2	-67	B
			Perchloroethylene	21.1 ± 0.5	-86	
80	H	Hazardous waste trial burn	Trichloroethylene	14.2 ± 0.7	+20	B
			1,1,1-Trichloroethane	13.3 ± 0.7	+20	
81	H	Hazardous waste trial burn	Freon 114	8.5 ± 1.3	+131	B
			Freon 113	10.1 ± 1.0	0	
			Vinylidene Chloride	10.9 ± 1.0	-16	
			Acetone	27.6 ± 5.7	-18	
			Toluene	30.8 ± 3.6	+78	
			1,4-Dioxane	28.8 ± 8.9	-79	
			Chlorobenzene	31.4 ± 3.6	+49	
82	CC	Hazardous waste trial burn	Carbon Tetrachloride	37.2 ± 1.1	-5	B
			Chloroform	8.1 ± 0.2	+10	
86	FF	Hazardous waste trial burn	Group I	7 - 90	NA	C

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
88	H	Hazardous waste trial burn	Carbon Tetrachloride	6.4 ± 0.2	+33	B
			Perchloroethylene	21.1 ± 0.5	+33	
89	Z	Hazardous waste trial burn	Carbon Tetrachloride	9.6 ± 0.3	+6	B
			Chloroform	37.1 ± 0.8	-2	
90	Z	Hazardous waste trial burn	Trichloroethylene	13.2 ± 0.7	+5	B
91	LL	Hazardous waste trial burn	Carbon Tetrachloride	16.9 ± 0.5	-22	B
92	LL	Hazardous waste trial burn	Trichloroethylene	13.2 ± 0.7	-1	B
93	W	Hazardous waste trial burn	Carbon Tetrachloride	73.9 ± 2.2	+14	B
			Chloroform	349.8 ± 7.4	-6	
			Perchloroethylene	319.9 ± 9.9	-6	
			Benzene	126.9 ± 4.1	+13	
			Vinyl Chloride	160.3 ± 5.2	+53	
94	H	Hazardous waste trial burn	Carbon Tetrachloride	11.4 ± 0.3	-4	B
95	MM	Hazardous waste trial burn	Group I	430 - 10,000	NA	C
96	NN	Hazardous waste trial burn	Carbon Tetrachloride	47.8 ± 1.5	+47	B
97	NN	Hazardous waste trial burn	Freon 113	30.2 ± 3.9	+48	B
101	H	Hazardous waste trial burn	Carbon Tetrachloride	9.6 ± 0.3	+108	B
			Chloroform	37.1 ± 0.8	+69	
			Perchloroethylene	9.1 ± 0.2	+60	
			Benzene	19.4 ± 0.6	+34	
			Vinyl Chloride	20.4 ± 0.7	+67	
102	H	Hazardous waste trial burn	Vinylidene Chloride	8.5 ± 1.1	+79	B
			Toluene	10.5 ± 3.4	+57	
			Chlorobenzene	10.8 ± 1.8	+47	

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
103	HH	Hazardous waste trial burn	Group I	90 - 430	NA	C
104	HH	Hazardous waste trial burn	Group III	90 - 430	NA	C
105	PP	Hazardous waste trial burn	Acetonitrile	11.3 ± 0.8	-64	B
			Methyl Ethyl Ketone	30.0 ± 1.6	-23	
			Trichloroethylene	10.2 ± 0.5	-11	
			1,2-Dichloroethane	9.7 ± 0.5	-6	
			Trichlorofluoromethane	10.1 ± 0.3	-29	
			Bromomethane	30.0 ± 1.3	-97	
			Dichlorodifluoromethane	26.3 ± 1.0	-69	
			1,2-Dibromoethane	32.0 ± 1.3	-20	
			1,1,1-Trichloroethane	31.7 ± 1.7	-9	
107	HH	Hazardous waste trial burn	Carbon Tetrachloride	13.7 ± 0.4	-12	B
			Perchloroethylene	69.9 ± 1.7	-4	
108	HH	Hazardous waste trial burn	Trichloroethylene	10.1 ± 0.5	-1	B
109	QQ	Hazardous waste trial burn	Group I	7 - 90	NA	C
110	QQ	Hazardous waste trial burn	Group I	90 - 430	NA	C
112	W	Hazardous waste trial burn	Carbon Tetrachloride	10.5 ± 0.3	+10	B
			Chloroform	40.5 ± 0.9	+14	
			Perchloroethylene	11.2 ± 0.3	+3	
			Benzene	19.7 ± 0.6	+41	
			Vinyl Chloride	19.4 ± 0.6	+8	

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
113	W	Hazardous waste trial burn	Acetonitrile	37.3 ± 2.6	-59	B
			Methyl Ethyl Ketone	17.7 ± 0.9	-56	
			Trichloroethylene	41.9 ± 2.1	+32	
			1,2-Dichloroethane	38.0 ± 2.0	+24	
			Trichlofluoromethane (F-11)	42.0 ± 1.3	-38	
			Bromomethane	25.4 ± 1.0	+43	
			1,2-Dibromoethane	22.2 ± 0.9	+75	
			1,1,1-Trichloroethane	21.2 ± 1.1	+22	
116	H	Hazardous waste trial burn	Carbon Tetrachloride	37.2 ± 1.1	+40	B
			Perchloroethylene	9.0 ± 0.2	+22	
121	XX	Hazardous waste trial burn	Carbon Tetrachloride	310 ± 9.2	-7	B
122	XX	Hazardous waste trial burn	Toluene	11.6 ± 0.8	-11	B
124	YY	Hazardous waste trial burn	Group I	7 - 90	NA	C
125	YY	Hazardous waste trial burn	Group II	7 - 90	NA	C
127	HH	Hazardous waste trial burn	Toluene	10.2 ± 0.7	-12	B
131	H	Hazardous waste trial burn	Group I	430 - 10,000	NA	C
132	W	Hazardous waste trial burn	Carbon Tetrachloride	37.2 ± 1.1	+1	B
			Chloroform	8.1 ± 0.2	+22	
			Perchloroethylene	9.0 ± 0.2	+51	
			Benzene	39.1 ± 1.3	-27	
			Vinyl Chloride	50.3 ± 1.6	-53	
137	O	Hazardous waste trial burn	Carbon Tetrachloride	70.0 ± 2.1	-21	B

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
138	O	Hazardous waste trial burn	Toluene	32.8 ± 2.3	-13	B
139	HH	Hazardous waste trial burn	Carbon Tetrachloride	10.5 ± 0.3	-3	B
142	Q	Hazardous waste trial burn	Group I	7 - 90	NA	C
143	AC	Hazardous waste trial burn	Group I	7 - 90	NA	C
144	VV	Hazardous waste trial burn	Carbon Tetrachloride	10.5 ± 0.3	-10	B
145	VV	Hazardous waste trial burn	Carbon Tetrachloride	310 ± 9.2	-6.5	B
149	A	Hazardous waste trial burn	Group I	7 - 90	NA	C
150	A	Hazardous waste trial burn	Group I	430 - 10,000	NA	C
153	HH	Hazardous waste trial burn	Group I	7 - 90	NA	C
154	HH	Hazardous waste trial burn	Group II	7 - 90	NA	C
159	AF	Hazardous waste trial burn	Carbon Tetrachloride Chloroform Perchloroethylene Benzene	291 ± 8.7 232 ± 4.9 365 ± 9.0 300 ± 9.7	-21 -25 -28 +23	B
160	AJ	Hazardous waste trial burn	Carbon Tetrachloride Chloroform Perchloroethylene Benzene Vinyl Chloride	21.4 ± 2.4 10.6 ± 0.6 20.6 ± 1.0 10.3 ± 0.5 29.4 ± 2.5	+12 +19 -5 +59 -46	B
161	AG	Hazardous waste trial burn	Carbon Tetrachloride	9.5 ± 2.6	-35	B

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
162	AG	Hazardous waste trial burn	Toluene	11.6 ± 0.8	+3	B
			Chlorobenzene	11.7 ± 1.9	+8	
170	AK	Hazardous waste trial burn	Acetonitrile	119 ± 8.3	+13	B
171	AK	Hazardous waste trial burn	Acrylonitrile	29.3 ± 2.0	+199	B
178	AM	Hazardous waste trial burn	Perchloroethylene	120 ± 2.9	-12	B
179	AM	Hazardous waste trial burn	Methylene Chloride	840 ± 35	-10	B
180	QQ	Hazardous waste trial burn	Chlorobenzene	28.5 ± 4.8	-8	B
181	W	Hazardous waste trial burn	Carbon Tetrachloride	291 ± 8.6	-74	B
			Chloroform	123 ± 2.6	-61	
			Perchloroethylene	104 ± 2.6	-52	
			Benzene	367 ± 11.8	-84	
			Vinyl Chloride	416 ± 13.6	-32	
184	A	Hazardous waste trial burn	Group I	7 - 90	NA	C
185	O	Hazardous waste trial burn	Trichloroethylene	10.1 ± 0.5	+14	B
186	O	Hazardous waste trial burn	Toluene	10.2 ± 0.7	+3	B
188	QQ	Hazardous waste trial burn	Carbon Tetrachloride	37.2 ± 1.1	-13	B
			Chloroform	8.1 ± 0.2	-22	
			Perchloroethylene	9.0 ± 0.2	-11	
			Benzene	39.1 ± 1.3	-27	
			Vinyl Chloride	50.1 ± 1.6	-44	
189	AN	Hazardous waste trial burn	Perchloroethylene	10.1 ± 0.3	-22	B

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
190	AN	Hazardous waste trial burn	Group I	90 - 430	NA	C
198	AD	Hazardous waste trial burn	Methyl Ethyl Ketone	12.7 ± 0.7	-47	B
			Trichloroethylene	8.6 ± 0.4	35	
			1,2-Dichloroethane	10.5 ± 0.5	-4	
			Trichlorofluoromethane	9.40 ± 0.3	+159	
			Bromomethane	10.1 ± 0.4	-64	
			Dichlorodifluoromethane	10.6 ± 0.4	-0.9	
			1,2-Dibromoethane	9.30 ± 0.4	+8	
			1,1,1-Trichloroethane	8.50 ± 0.4	+19	
199	AO	Hazardous waste trial burn	Carbon Tetrachloride	14.4 ± 0.4	-5	B
200	AO	Hazardous waste trial burn	Toluene	10.2 ± 0.7	-12	B
			Chlorobenzene	29.8 ± 5.0	-29	
202	AP	Hazardous waste trial burn	Acetonitrile	12.8 ± 0.8	-92	B
			Trichloroethylene	15.6 ± 0.8	5	
			1,1,1-Trichloroethane	14.4 ± 0.8	11	
203	AK	Hazardous waste trial burn	Group II	90 - 430	NA	C
204	AK	Hazardous waste trial burn	Group IV	430 - 10,000	NA	C
205	AA	Hazardous waste trial burn	Carbon Tetrachloride	10.8 ± 0.3	-25	B
			Chloroform	43.3 ± 0.9	-26	
			Perchloroethylene	10.6 ± 0.2	-35	
			Benzene	21.8 ± 0.7	-23	
			Vinyl Chloride	19.7 ± 0.6	-8	
206	W	Hazardous waste trial burn	Carbon Tetrachloride	20.7 ± 3.7	-33	B
207	W	Hazardous waste trial burn	Methyl Ethyl Ketone	12.7 ± 0.7	+21	B

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
208	W	Hazardous waste trial burn	Chlorobenzene	11.2 ± 1.8	+24	B
218	AT	Hazardous waste trial burn	Carbon Tetrachloride	20.8 ± 2.0	+70	B
			Chloroform	10.3 ± 0.3	+50	
			Perchloroethylene	20.3 ± 0.6	-1	
			Benzene	10.4 ± 0.5	+38	
			Vinyl Chloride	30.3 ± 2.1	+9	
219	AT	Hazardous waste trial burn	Group II	7 - 90	NA	C
220	AT	Hazardous waste trial burn	Group III	7 - 90	NA	C
221	O	Hazardous waste trial burn	Carbon Tetrachloride	10.1 ± 1.0	-10	B
222	O	Hazardous waste trial burn	Toluene	11.6 ± 0.8	-19	B
224	AG	Hazardous waste trial burn	Trichlorofluoromethane (F-11)	16.9 ± 1.4	-10	B
226	AU	Hazardous waste trial burn	Carbon Tetrachloride	9.45 ± 0.3	+67	B
			Chloroform	40.6 ± 0.9	-38	
			Benzene	19.2 ± 0.6	+5	
235	PP	Hazardous waste trial burn	Trichloroethylene	39.2 ± 1.2	-84	B
			1,2-Dichloroethane	39.8 ± 1.2	-46	
			Trichlorofluoromethane (F-11)	33.5 ± 2.9	-89 to -72	
			1,2-Dibromoethane	NA	NA	
			1,1,1-Trichloroethane	19.8 ± 0.6	-63	
236	AA	Hazardous waste trial burn	Group I	7 - 90	NA	C

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
239	AD	Hazardous waste trial burn	Carbon Tetrachloride	75.9 ± 7.1	-0.7	B
			Chloroform	7.5 ± 7.1	-10	
			Perchloroethylene	78.3 ± 14.9	-75	
			Benzene	71.4 ± 9.0	+14	
			Vinyl Chloride	75.8 ± 19.2	-47	
241	VV	Hazardous waste trial burn	Carbon Tetrachloride	10.4 ± 0.90	+2	B
			Chloroform	25.8 ± 2.31	+3	
			Perchloroethylene	8.05 ± 0.57	-6	
			Benzene	29.0 ± 2.45	-6	
			Vinyl Chloride	19.8 ± 1.27	-22	
247	BF	Hazardous waste trial burn	Carbon Tetrachloride	35.6 ± 3.8	+4	B
			Chloroform	9.02 ± 1.7	-11	
			Perchloroethylene	9.15 ± 1.2	-78	
			Benzene	37.3 ± 3.9	-8	
			Vinyl Chloride	52.0 ± 7.6	-76	
248	AP	Hazardous waste trial burn	1,1,1-Trichloroethane	20.3 ± 0.6	+25	B
252	KK	Hazardous waste trial burn	Carbon Tetrachloride	7.00 ± 0.72	-4.3	B
253	KK	Hazardous waste trial burn	Trichlorofluoromethane (F-11)	10.1 ± 0.3	-14	B
			Dichlorofluoromethane (F-12)	26.3 ± 1.0	+269	B
258	BD	Hazardous waste trial burn	Chlorobenzene	4.31 ± 0.26	-7	B
			Ethylbenzene	4.21 ± 0.25	+12	

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
259	BD	Hazardous waste trial burn	Methyl Ethyl Ketone	135 ± 6.6	+19	B
260	BE	Hazardous waste trial burn	Group I	7 - 90	NA	C
261	AA	Hazardous waste trial burn	Group III	7 - 90	NA	C
262	BE	Hazardous waste trial burn	Group I	7 - 90	NA	C
263	BE	Hazardous waste trial burn	Group II	7 - 90	NA	C
265	BF	Hazardous waste trial burn	Group III	7 - 90	NA	C
268	BF	Hazardous waste trial burn	Methylene Chloride	10.1 ± 1.42	+19	B
269	BI	Hazardous waste trial burn	Group I	7 - 90	NA	C
270	BH	Hazardous waste trial burn	Group I	7 - 90	NA	C
271	BH	Hazardous waste trial burn	Methyl Ethyl Ketone	8.20 ± 0.4	-51	B
			Trichloroethylene	9.20 ± 0.3	+12	
			1,2-Dichloroethane	8.98 ± 0.3	+22	
			Trichlorofluoromethane	9.60 ± 0.8	-56	
			1,2-Dibromoethane	10.8 ± 0.4	-7	
			1,1,1-Trichloroethane	NA	NA	
272	BJ	Hazardous waste trial burn	Carbon Tetrachloride	20.9 ± 1.79	+3	B
			Chloroform	11.2 ± 1.22	-14	
			Perchloroethylene	21.2 ± 1.91	-7	
			Benzene	10.4 ± 1.11	-15	
			Vinyl Chloride	29.1 ± 2.08	+78	
273	BK	Hazardous waste trial burn	Carbon Tetrachloride	20.4 ± 2.15	-9	B
			Perchloroethylene	22.9 ± 1.54	-14	

(continued)

Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
274	BL	Hazardous waste trial burn	Benzene	29.0 ± 2.45	-100	B
277	BM	Hazardous waste trial burn	Group I	7 - 90	NA	C
278	BM	Hazardous waste trial burn	Group I	7 - 90	NA	C
279	BN	Hazardous waste trial burn	Carbon Tetrachloride Perchloroethylene	10.3 ± 1.19 11.4 ± 0.99	+17 -4	B
280	BO	Hazardous waste trial burn	Group III	7 - 90	NA	C
281	BP	Hazardous waste trial burn	Group I	7 - 90	NA	C
284	AA	Hazardous waste trial burn	Group III	7 - 90	--	A
285	AA	Hazardous waste trial burn	Group III	90 - 430	--	A
286	W	Hazardous waste trial burn	Carbon Tetrachloride	11.2 ± 0.8	+36	B
287	W	Hazardous waste trial burn	Trichlorofluoromethane	15.4 ± 1.2	+97	B
288	W	Hazardous waste trial burn	Chloroform	10.2 ± 0.8	-6	B
289	W	Hazardous waste trial burn	Toluene	10.6 ± 0.8	+23	B
290	BR	Hazardous waste trial burn	Group I	7 - 90	--	A
291	BR	Hazardous waste trial burn	Group III	7 - 90	--	A
292	O	Hazardous waste trial burn	Carbon Tetrachloride	9.79 ± 1.1	+10	B
293	O	Hazardous waste trial burn	Chlorobenzene	10.8 ± 1.3	-8	B
294	BJ	Hazardous waste trial burn	Group I	7 - 90	NA	C

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Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
295	BJ	Hazardous waste trial burn	Group III	7 - 90	NA	C
296	BS	Hazardous waste trial burn	Carbon Tetrachloride Perchloroethylene	10.5 ± 0.9 10.6 ± 0.8	+14 +14	B
302	DD	Hazardous waste trial burn	Carbon Tetrachloride	133 ± 4.0	+20	B
303	DD	Hazardous waste trial burn	Toluene	32.2 ± 2.4	+4	B
310	BU	Hazardous waste trial burn	Carbon Tetrachloride Perchloroethylene	20.0 ± 1.4 21.3 ± 2.1	+45 +8	B
311	BV	Hazardous waste trial burn	Carbon Tetrachloride Chloroform Perchloroethylene Benzene Vinyl Chloride	20.8 ± 2.9 12.0 ± 1.4 22.9 ± 1.6 11.0 ± 1.0 32.9 ± 3.8	+12 -17 -6 -3 -64	B
313	W	Hazardous waste trial burn	Carbon Tetrachloride	15.5 ± 0.9	+47	B
314	W	Hazardous waste trial burn	Chlorobenzene	11.1 ± 1.4	+110	B
315	W	Hazardous waste trial burn	Methylene Chloride	10.7 ± 0.8	+22,377	B
316	A	Hazardous waste trial burn	Perchloroethylene	16.6 ± 1.4	+16	B
317	A	Hazardous waste trial burn	Chlorobenzene	11.2 ± 1.5	-3 +34	B
318	W	Hazardous waste trial burn	Carbon Tetrachloride	20.4 ± 2.2	-9	B
319	W	Hazardous waste trial burn	Toluene Chlorobenzene	11.2 ± 0.9 11.1 ± 1.7	+51 +105	B
320	W	Hazardous waste trial burn	Methylene Chloride	30.2 ± 2.2	-6	B

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Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
321	W	Hazardous waste trial burn	Carbon Tetrachloride	13.1 ± 1.6	+15	B
			Chloroform	16.7 ± 2.9	-16	
			Perchloroethylene	80.7 ± 6.3	-38	
			Benzene	53.7 ± 4.8	-20	
			Vinyl Chloride	33.3 ± 34	-34	
322	HH	Hazardous waste trial burn	Perchloroethylene	10.6 ± 1.1	+11	B
323	HH	Hazardous waste trial burn	Chlorobenzene	11.2 ± 1.5	-13	B
324	BJ	Hazardous waste trial burn	Carbon Tetrachloride	9.99 ± 1.2	+11 +2 +15	B
325	BJ	Hazardous waste trial burn	Freon 113	20.3 ± 1.6	+1 +28 -4	B
326	W	Hazardous waste trial burn	Chloroform	11.2 ± 1.2	-10	B
327	W	Hazardous waste trial burn	Toluene	10.6 ± 0.8	+169	B
			Chlorobenzene	10.3 ± 1.2	+64	
328	AD	Hazardous waste trial burn	Carbon Tetrachloride	49.7 ± 3.1	+9	B
			Chloroform	10.2 ± 0.8	+39	
			Perchloroethylene	11.4 ± 0.7	+25	
			Benzene	48.0 ± 3.3	+12	
			Vinyl Chloride	52.0 ± 4.2	-28	
329	W	Hazardous waste trial burn	Carbon Tetrachloride	10.2 ± 1.5	+116	B
			Perchloroethylene	11.6 ± 1.0	+51	
332	BJ	Hazardous waste trial burn	Group I	7 - 90	NA	C
333	BJ	Hazardous waste trial burn	Group IV	7 - 90	NA	C
334	BW	Hazardous waste trial burn	Freon 113	29.7 ± 2.2	+3	B

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Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
338	W	Hazardous waste trial burn	Group II	90 - 430	NA	C
339	AU	Hazardous waste trial burn	Group II	7 - 90	--	A
340	AU	Hazardous waste trial burn	Group III	7 - 90	--	A
341	O	Hazardous waste trial burn	Trichlorofluoromethane	10.1 ± 0.7	+3	B
342	S	Hazardous waste trial burn	Carbon Tetrachloride	11.7 ± 0.9	+11	B
343	S	Hazardous waste trial burn	Chlorobenzene	31.9 ± 3.7	+12	B
345	BX	Hazardous waste trial burn	Group I	7 - 90	--	A
346	BX	Hazardous waste trial burn	Group II	7 - 90	--	A
348	W	Hazardous waste trial burn	Carbon Tetrachloride	6.32 ± 0.7	+13	B
349	W	Hazardous waste trial burn	Group II	7 - 90	NA	C
350	W	Hazardous waste trial burn	Carbon Tetrachloride Methylene Chloride Toluene	11.2 ± 0.8 9.81 ± 1.0 4.35 ± 0.3	-3 +198 +654	B
352	H	Hazardous waste trial burn	Group I	7 - 90	--	A
354	BY	Hazardous waste trial burn	Group I	7 - 90	--	A
355	BZ	Hazardous waste trial burn	Carbon Tetrachloride Perchloroethylene	803 ± 46 856 ± 63	-6 -34	B
356	O	Hazardous waste trial burn	Carbon Tetrachloride	20.4 ± 2.2	-4	B
357	O	Hazardous waste trial burn	Trichlorofluoromethane	16.4 ± 1.2	-7	B

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Summary of Performance Audit Results (continued)

Audit No.	Client*	Use of audit material	Audit material**	RTI audit conc. (ppb)	Client audit % bias (avg.)***	Status of audit****
358	AD	Hazardous waste trial burn	Group I	7 - 90	--	A
359	W	Hazardous waste trial burn	Carbon Tetrachloride	72.7 ± 4.1	+10	B
360	W	Hazardous waste trial burn	1,1,1-Trichloroethane	14.3 ± 0.7	+117	B
367	W	Hazardous waste trial burn	Group I	7 - 90	--	A
368	W	Hazardous waste trial burn	Group III	7 - 90	--	A
371	W	Hazardous waste trial burn	Group I	7 - 90	--	A
372	W	Hazardous waste trial burn	Group II	7 - 90	--	A
374	H	Hazardous waste trial burn	Group I	7 - 90	--	A
375	H	Hazardous waste trial burn	Group III	7 - 90	--	A

*Whenever the auditee is known, an alphabetical letter is shown. Whenever the auditee is unknown or the audit is a self-audit, the name of the agency requesting the audit is shown.

**Group I, II, III, and IV compounds are listed in Table 1 of this report.

***Client % Bias = $100 \times \dfrac{\text{Client-Measured Concentration - RTI-Measured Concentration}}{\text{RTI-Measured Concentration}}$

****Status Codes:
A = Audit not complete
B = Audit complete
C = Audit completed without results
NA = Not analyzed by auditee.

*****Audit of instrument calibration procedure.